

# **FY 2003 FEMP GPRA Metrics Methodology, Assumptions, and Explanations<sup>1</sup>**

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## **Major Methodology Changes From FY 2002 Metrics<sup>2</sup>**

1. Federal metrics were aggregated from metrics developed for DOD, DOE, GSA, USPS, VA, and all other agencies grouped together. Previously, metrics were only developed at the Federal level. DOD, DOE, GSA, USPS, and VA were selected for specific metric development because they are the five largest agencies measured by square footage, energy consumption, or energy dollar expenditure.
2. Reduction in the future energy use intensity (EUI, measured in Btu/square foot) from FY 2000 through FY2010 was estimated for each of the five agencies noted above and all other agencies grouped together. Previously, the Federal EUI was assumed to match the goals for FY 2005 and FY 2010.
3. EUI was assumed to continue declining by a factor of 0.99 per year after FY 2010 for all agencies. Previously, EUI was assumed to remain at the goal for FY 2010 after FY 2010.
4. At the direction of Skye Schell, FEMP, the base year for measuring the impact of the budget request was moved forward to the year prior to the budget request. For example, the base year for the FY 2003 budget request is now FY 2002. Previously, the base year was the last year for which *actual* energy consumption, dollar expenditure, and building square footage data were available. For the FY 2003 metrics, the last year of actual available data are from FY 2000. Thus the future impacts are now based on an estimated rather than actual baseline, but only take credit for impacts that could possibly be affected by the FY 2003 budget. The result is a significant reduction in estimated impacts, particularly when viewed on a percentage basis for the first few years from FY 2003.
5. Reference year (FY 1990) energy consumption, energy expenditures, and building square footage for Energy Intensive Operations (EIOps) are now based on data reported by the agencies. In previous years, EIOps square footage varied wildly for DOD for the years 1987 through 1992. In fact, the reported DOD EIOps square footage was 0 in 1989, 1990, and 1991 even though the reported energy use was substantial. Therefore, raw data for EIOps were previously adjusted for 1987 through 1992 to more reasonable figures. DOD is now reporting an EIOps square footage figure for FY 1990 that is roughly consistent with figures reported for years prior and subsequent to this date. The impact of this change is a 21%

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<sup>1</sup> Details regarding the calculation of the Metrics can be found in the Excel spreadsheet, FY2003 GPRA Input Worksheet Version 4.

<sup>2</sup> Applies to “normal” buildings only. Metrics for “energy intensive operations” are calculated separately per the same methodology used in previous years except as noted in Item #5. Energy intensive operations represent about 10% of the Federal government building stock.

increase in the EUI for EIOps in FY 1990, the reference year for EIOps efficiency goals, without any significant change in the current EUI. As a result, the FY 2010 goal for EIOps has nearly been met and estimated energy savings from FY 2000 to FY 2010 dropped by about 85% compared to that estimated for the FY 2002 GPRA Metrics.

### **Approach for Estimating EUI Reduction**

1. Estimates for agency-specific reductions in EUI for FY 2000 through FY 2010 were aggregated from estimates due to a) cost-effective retrofits of building energy systems, b) replacement of equipment upon failure (with generally more efficient equipment), c) cost-effective retrofits of central energy plants and thermal distribution systems (DOD, DOE, and VA only), d) construction of new housing (DOD only), and e) improvements in O&M practices.
2. The reduction in EUI for Federal agencies was based mostly on data developed in two PNNL reports, *Economic Energy Savings Potential in Federal Buildings*, and *An Assessment of Prospective FORSCOM Energy Intensities*. The former was prepared for FEMP by D. Brown, J. Dirks, and D. Hunt; the latter for the U.S. Army's Forces Command (FORSCOM) by D. Brown and J. Dirks. The estimated decrease in EUI from improved O&M practices was developed from data presented in *Using Targeted Energy Efficiency Programs to Reduce Peak Electrical Demand and Address Electric System Reliability Problems* by S. Nadel et al of ACEEE and *Energy and Comfort Benefits of Continuous Commissioning in Buildings* by D. Claridge et al of Texas A&M University.
3. Cost-effective retrofits of building energy systems represent approximately 40% to 60% of the estimated reduction in EUI for each agency.
4. The cost-effective retrofit potential of building energy systems was based on private financing from ESCOs rather than government funding.
5. Based on an extrapolation of privately-funded retrofits of federal buildings to date, 50% of the cost-effective retrofit potential was estimated to be captured by the year 2010.

### **Consistent with FY 2002 Metrics**

1. Historical energy consumption, energy cost, and building square footage data were used through FY 2000. Historical data were provided by Chris Tremper, McNeil Technologies.
2. Future building square footage (SF) was set equal to the FY 2000 value. That is, no change in SF was assumed, based on recent historical trends.
3. Btu/SF was reduced from the actual FY 2000 value to the estimated FY 2010 values via a constant per cent reduction for each year between FY 2000 and FY 2010 for buildings.
4. Btu/SF was reduced from the FY 2000 value to the FY 2010 goal via a constant percent reduction for each year between FY 2000 and FY 2010 for EI operations.

5. FEMP programs can potentially impact 100% of energy use in EI operations (no exclusion of process energy).
6. FEMP programs are responsible for 50% of federal energy savings resulting from future reductions in energy use per square foot of building area. Non-FEMP activities, including site-specific and DoD ESPCs, changing building stock via new construction and demolition, and replacement of equipment upon failure (rather than cost-effective retrofits) account for the remainder.
7. The future fuel mix is assumed to be the same as that for FY 2000. However, it is worth noting that the historical fuel mix has changed dramatically in federal buildings, with sharp decreases in the fraction of fuel oil and coal, and a significant increase in the fraction of electricity use.
8. Coal is used to generate purchased steam.
9. Purchased steam generation and distribution is 72% efficient, consistent with the assumptions used by Chris Tremper for the Annual Report to Congress. We may want to revisit this assumption in the future because limited data suggest the actual efficiency of steam generation and distribution is significantly lower.
10. Emissions factors for non-electricity energy forms are from the official 2003 GPRA Data Call, provided by the EE Office of Planning, Budget and Management, and are the same for all years past, present, and future.
11. Electricity emissions factors are as specified in the *GPRA Data Call* for 2003 forward, with interpolation for intermediate years not specified in the Data Call. Electricity emissions factors for 2001 and 2002 were assumed to be the same as for 2003. Electricity emissions factors for 1985 through 2000 were calculated based on the actual mix of power generators, rather than the presumed marginal mix for years 2001 to 2030. Note that historical emissions factors are generally lower because roughly 30% of the generation mix is hydro and nuclear, which has no air emissions impacts.
12. Future fuel prices for federal buildings and EI operations were based on their respective average fuel prices during 2000, with future real escalation based on the change in future commercial fuel prices presented in the 2001 *Annual Energy Outlook*. Commercial sector fuel prices were judged to be more representative of the federal sector than residential or industrial sector fuel prices, the other two choices in the 2001 AEO. An exception is coal, where we based the change on future industrial steam coal prices because no projections of future coal prices are provided for the commercial sector. 2000 dollars were converted to 1999 dollars per requirements of the 2003 GPRA Data Call using the GDP implicit price deflator.
13. The energy content for fuel oil (Btu/barrel) is based on distillate and that for coal (Btu/short ton) is based on "industrial" coal per the 2003 *GPRA Data Call*.
14. Other fuel energy contents (Btu per unit of consumption) are per the 2003 *GPRA Data Call*.
15. Source energy multipliers or heat rates for electricity were based on specified heat rates in the GPRA Data Call for 2003 through 2030, with interpolations as necessary. 1985-2000 multipliers were based on average historical heat rates and work done for DOE/BTS by

PNNL researcher Dave Belzer. Belzer analyzed historical heat losses from the power sector and created a “Heat Loss Rate” spreadsheet analysis through 1995, which we employed, updating it for 1996-2000 with data from 1999, 2000, and 2001 AEOs. The figures for 2001 and 2002 are based on interpolation between 2000 and 2003 estimates.

16. Note that the 1985-2000 source energy multipliers or heat rates are *averages* for the electricity industry, while post 2002 GPRA multipliers are based on an assumed *marginal* generation mix displaced by energy conservation. The 2003 GPRA Data call assumed a mixture of coal, oil, and natural gas fired power plants in its marginal generation mix based on a comparison of the generation mix for the AEO 2001 reference case and a case with reduced electricity demand. Interestingly, the numbers are nearly the same for 2000 and 2003.

**FY 2003 GPRA Summary**  
**Buildings and Energy Intensive Operations**  
*Figures are for FEMP Share of Total Impact*

Year	Annual Energy Metrics								
	Total Primary Energy Displaced (TBtu)	Direct Electricity Displaced (billion kWh)	Direct Natural Gas Displaced (billion CF)	Direct Petroleum Displaced (million barrels)	Direct Coal Displaced (million short tons)	Direct Biomass Displaced, (TBtu)	Direct Energy Displaced from Feedstocks (TBtu)	Direct Energy Displaced from Wastes (TBtu)	Other Direct Energy Displaced (TBtu)
2003	5.51	0.368	0.89	0.0513	0.0126	0	0	0	0
2004	10.87	0.729	1.77	0.1018	0.0249	0	0	0	0
2005	16.04	1.084	2.63	0.1514	0.0371	0	0	0	0
2006	20.53	1.433	3.48	0.2002	0.0490	0	0	0	0
2007	25.40	1.776	4.31	0.2482	0.0607	0	0	0	0
2010	36.63	2.769	6.73	0.3873	0.0948	0	0	0	0
2015	48.38	3.876	9.47	0.5406	0.1328	0	0	0	0
2020	59.69	4.928	12.07	0.6864	0.1689	0	0	0	0
2025	71.82	5.929	14.54	0.8250	0.2032	0	0	0	0
2030	83.36	6.881	16.89	0.9569	0.2359	0	0	0	0

Year	Annual Environmental Metrics							
	Carbon Emissions Displaced (MMTC)	Other Green-house Emissions Displaced (MMTCe)	CO Displaced (MT)	SO2 Displaced (MT)	NOx Displaced (MT)	VOCs Displaced (MT)	PM10 Displaced (MT)	Other Environmental Benefits (MT)
2003	0.098	0	125	1,114	799	16.13	21.8	0
2004	0.195	0	247	2,268	1,607	31.80	43.0	0
2005	0.295	0	353	3,667	2,497	35.42	74.8	0
2006	0.387	0	437	5,170	3,324	45.49	95.6	0
2007	0.495	0	505	7,150	4,327	56.30	136.2	0
2010	0.717	0	730	8,304	5,039	65.40	163.8	0
2015	0.924	0	1,000	9,379	5,705	73.90	191.5	0
2020	1.122	0	1,274	10,378	6,329	81.83	219.4	0
2025	1.350	0	1,533	10,905	6,710	87.59	228.4	0
2030	1.567	0	1,780	11,390	7,069	93.16	236.3	0

<b>Annual Financial Metrics</b>						
<b>Year</b>	<b>Energy Cost Savings (millions of 1999\$)</b>	<b>Non-Energy Cost Savings (millions of 1999\$)</b>	<b>Consumer Investment (millions of 1999\$)</b>	<b>EERE Expenditures (millions of 1999\$)</b>	<b>Other Government Expenditures (millions of 1999\$)</b>	<b>Private Sector Expenditures (millions of 1999\$)</b>
<b>2003</b>	27.6	0	0	\$27.8		
<b>2004</b>	54.1	0	0	\$27.8		
<b>2005</b>	79.7	0	0	\$27.8		
<b>2006</b>	103.8	0	0	\$27.8		
<b>2007</b>	126.9	0	0	\$27.8		
<b>2010</b>	189.9	0	0	\$27.8		
<b>2015</b>	264.6	0	0	\$27.8		
<b>2020</b>	342.6	0	0	\$27.8		
<b>2025</b>	400.6	0	0	\$27.8		
<b>2030</b>	453.1	0	0	\$27.8		

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: \$27.8 Million is the FEMP Budget Request as of early December 2001. The actual budget request to Congress could be somewhat different. Also, note that this is FEMP's budget request to Interior only. The Energy and Water DEMF request is not included here.

<b>Cumulative Energy Metrics</b>									
<b>Year</b>	<b>Total Primary Energy Displaced (TBtu)</b>	<b>Direct Electricity Displaced (billion kWh)</b>	<b>Direct Natural Gas Displaced (billion CF)</b>	<b>Direct Petroleum Displaced (million barrels)</b>	<b>Direct Coal Displaced (million short tons)</b>	<b>Direct Biomass Displaced, (TBtu)</b>	<b>Direct Energy Displaced from Feedstocks (TBtu)</b>	<b>Direct Energy Displaced from Wastes (TBtu)</b>	<b>Other Direct Energy Displaced (TBtu)</b>
<b>2003</b>	5.51	0.37	0.89	0.05	0.01	0	0	0	0
<b>2004</b>	16.38	1.10	2.66	0.15	0.04	0	0	0	0
<b>2005</b>	32.42	2.18	5.29	0.30	0.07	0	0	0	0
<b>2006</b>	52.95	3.61	8.77	0.50	0.12	0	0	0	0
<b>2007</b>	78.35	5.39	13.09	0.75	0.18	0	0	0	0
<b>2010</b>	177.58	12.71	30.89	1.78	0.44	0	0	0	0
<b>2015</b>	396.84	29.90	72.82	4.18	1.02	0	0	0	0
<b>2020</b>	673.20	52.46	128.02	7.32	1.80	0	0	0	0
<b>2025</b>	1008.28	80.12	195.83	11.17	2.74	0	0	0	0
<b>2030</b>	1402.26	112.64	275.64	15.69	3.86	0	0	0	0

Year	Cumulative Environmental Metrics							
	Carbon Emissions Displaced (MMTC)	Other Green-house Emissions Displaced (MMTCe)	CO Displaced (MT)	SO2 Displaced (MT)	NOx Displaced (MT)	VOCs Displaced (MT)	PM10 Displaced (MT)	Other Environmental Benefits (MT)
2003	0.098	0	125	1,114	799	16	22	0
2004	0.293	0	372	3,382	2,407	48	65	0
2005	0.588	0	724	7,049	4,904	83	140	0
2006	0.976	0	1,161	12,219	8,228	129	235	0
2007	1.470	0	1,666	19,369	12,555	185	371	0
2010	3.409	0	3,642	47,429	29,628	406	946	0
2015	7.635	0	8,112	106,411	66,570	898	2,158	0
2020	12.863	0	13,939	175,953	111,693	1,521	3,608	0
2025	19.161	0	21,092	258,429	165,855	2,277	5,362	0
2030	26.565	0	29,503	355,373	229,532	3,167	7,425	0

<b>Cumulative Financial Metrics</b>						
<b>Year</b>	<b>Energy Cost Savings (millions of 1999\$)</b>	<b>Non-Energy Cost Savings (millions of 1999\$)</b>	<b>Consumer Investment (millions of 1999\$)</b>	<b>EERE Expenditures (millions of 1999\$)</b>	<b>Other Government Expenditures (millions of 1999\$)</b>	<b>Private Sector Expenditures (millions of 1999\$)</b>
<b>2003</b>	27.61	0	0	27.8		
<b>2004</b>	81.75	0	0	55.6		
<b>2005</b>	161.41	0	0	83.4		
<b>2006</b>	265.22	0	0	111.2		
<b>2007</b>	392.09	0	0	139.0		
<b>2010</b>	900.64	0	0	166.8		
<b>2015</b>	2075.29	0	0	194.6		
<b>2020</b>	3632.32	0	0	222.4		
<b>2025</b>	5521.83	0	0	250.2		
<b>2030</b>	7684.43	0	0	278.0		